E-2810

INSTRUCTION MANUAL
FOR
SORENSEN
ISOTRONIC PRODUCTS

NOBATRONS

2702

SORENSEN & CO., INC.
375 FAIRFIELD AVE., STAMFORD, CONN.

INSTRUCTION MANUAL

FOR

SORENSEN NOBATRONS

GENERAL INFORMATION

Before you begin to use your new Sorensen instrument, please read this instruction book very carefully.

The Sorensen Nobatron is a precision instrument. This does not mean that your Sorensen instrument will not stand rough handling - it will. How much, will, of course, depend on your own experience and good judgment. You have chosen the Sorensen unit over all other similar types of equipment for any of the reasons listed -

- Wide Input Range
- Precise regulation accuracy
- Low Ripple
- Insensitivity to line frequency fluctuations
- Adjustable output voltage
- Fast recovery time

The experience and "know-how" which have made Sorensen the first line of STANDARD electronic voltage regulators, stand behind this instrument. If, for any reason, difficulties are encountered, notify the factory at once ... DO NOT ATTEMPT ADJUSTMENTS OR REPAIRS WITHOUT FIRST NOTIFYING THE FACTORY. DO NOT TAMPER WITH ANY OF THE COMPONENTS. UNINSTRUCTED TAMPERING WITH ANY OF THE COMPONENTS WILL VOID YOUR GUARANTEE FOR THAT PARTICULAR PART.

REQUESTS FOR INFORMATION AND SERVICE

All questions concerning the operation or malfunctioning of this instrument should be directed to the Service Department, Sorensen & Company, 375 Fairfield Avenue, Stamford, Connecticut.

Sorensen & Company, Inc. has adopted a sales and service policy which is meant to be a protection to you as purchaser and Sorensen & Company, Inc. as supplier.

INSPECT INSTRUMENTS AT ONCE FOR SHIPPING DAMAGE

All shipments should be inspected by the buyer upon delivery and in the event of damage in transit, a claim should be filed against the carrier at once.

WARRANTY

Defective instruments or defective components found in the instruments will be considered for adjustment only if Sorensen & Company, Inc. is notified within the Warranty period specified. The period of Warranty (with the exception of the tubes) for this instrument is one year from date of your acceptance.

THE THERMOSEN DIODE IS UNCONDITIONALLY GUARANTEED FOR 2500 HOURS OR ONE YEAR, WHICHEVER EXPIRES FIRST.

The instrument and materials are warranted against defective workmanship and construction, and no other warranty may be implied.

The warranty only covers equipment that is maintained in proper condition and is used by you in skillful and proper manner. No other warranties may be implied.

PROCEDURE FOR RETURNING DAMAGED OR DEFECTIVE MATERIAL

When claiming adjustments for defective materials, the following procedure should be followed:

A. A request should be made directly to the Service Department of Sorensen & Company, Inc. for authorization to return the defective instrument. In order that your

request can be serviced as quickly as possible, it is necessary to list the following information:

1. The order number on which the instrument was shipped.

2. Model number and serial number of the instrument.

3. A brief description of the reason for rejection.

B. It will be determined by the Service Department of Sorensen & Company, Inc. whether a repair will be attempted at your plant by one of our Field Engineers or Representatives. If this is to be done we will notify you immediately and make arrangements for a visit to your plant. If we indicate that the material is to be returned to our Plant for repair or replacement, a RETURN MATERIAL TAG, which outlines a shipping procedure, will be sent to you.

SPECIFICATIONS

1. Input Voltage Range - 95 to 130 volts AC (or 190 to 260 in some models) and 95/164 - 130/225 3 phase 4 wire in 3 phase units.

2. Output voltage may be 6, 12, 28, 125 or 200 depending on the model. All models have voltage output adjustment of +10%-25% except the 6 volt models which have a 7V tap and are adjustable to ±10% on each tap.

3. Regulation accuracy - plus or minus 0.2% against line at any fixed load from 1/10 to full load and ±0.2% from 1/10 load to full load at any fixed line voltage within rating.

   The regulation is plus or minus 2% from *no load* to *full load* at any fixed voltage within rating.

   Above regulation accuracy applies at normal indoor temperature and at any voltage setting within plus or minus 10% of the nominal voltage of the unit.

   At settings between minus 10% and minus 25% of the nominal, regulation accuracy is not guaranteed. However, regulation is likely to be within specified accuracy except at a combination of high line voltage and light load. For example, at 1/10 load and maximum input, unit may not regulate below the -10% output setting but at half load at normal line may still regulate at the -25% output setting.

4. Recovery Time- 0.2 seconds for ratings to 1KW capacity up to a maximum of 0.5 seconds on 10 K.W. capacity models. When an abrupt change occurs in the input voltage or in the load, a change occurs in output voltage. The magnitude of the output-voltage-change is dependent upon the magnitude of the change in load or input voltage. A finite time is necessary for the regulator to restore the output voltage from its maximum deviated value to the normal value. Recovery time is defined as the time necessary to effect 63% recovery from the maximum deviated value.

5. Input frequency range - 50 to 60 cycles.

6. Load Range - 0 to full load Model number indicates voltage and current capacity of the unit.

7. Ripple - 1% RMS maximum. This rating applies to a nominal input frequency of 60 cycles, at normal room temperature. At 50 cycles the ripple may increase to twice the 60 cycle value.

8. Unit will operate at ambients from -20°C. to 35°C. Regulation is not guaranteed with changes in ambient

and ripple is not guaranteed below normal room temperature.

9. Most units are fully protected against overload by automatic thermal breakers. The special diode employed protects the unit against over voltage resulting from diode tube failure.

10. The unit is rated to withstand normal humidity conditions in a sheltered location. The wound components are varnish impregnated in a good commercial manner.

    NOTE: Dangerous voltages exist in the control circuits. Observe appropriate precautions.

11. The controls are located on the front panel. An input power switch is provided for all models except the large self-contained units some of which have a line contactor energized by switch on control panel. A control circuit fuse is located on the front panel. This fuse does not disconnect the power unit. A pilot light is also provided to indicate that an AC voltage is being applied to the control circuit. A voltage adjustment control is also located on the front panel.

    It must be noted that to completely disconnect all possible voltages from the load or from the internal portions of the unit, the power or control switch should be off, or the connection to the main power opened. Removing the control circuit fuse will not completely remove all voltages from the unit or the load but merely disconnects the A.C. voltage from the control circuit. See the schematic for details.

12. The standard finish is grey wrinkle although black wrinkle is also available.

13. On multiple output voltage units a switch is provided to change from one range to another. Since these units are not designed to change ranges under load the input switch should be turned off before switching range.

INSTALLATION NOTES

Input Power is connected to a terminal board in the lower left corner of unit (in smaller chassis of two chassis units). Input wire should be No. 14 on single chassis units and No. 8 on two chassis units.

Output Power is taken from terminal board in lower right corner of single chassis units or upper left corner of larger chassis of two chassis units. Use an adequate wire size on output leads to minimize external voltage drop. Both terminal boards are accessible by removing front panel. Grommet holes are provided on the side of the chassis.

In two chassis units an interconnecting cable is provided using Jones Plug and Socket Connections.

On large self-contained units a supplementary instruction sheet is provided.

The chassis is isolated from the input and output terminals and it is recommended that the chassis and case be grounded. The input is isolated from the output.

The fuse on the front panel is provided as a protection for the control components in the event of an internal failure. The unit is protected against overload by the internal automatic type over-current protector in most models.

PRINCIPLE OF OPERATION

The operation of the unit can best be understood by referring to the schematic diagrams included.

The basic power circuit includes an autotransformer T4, a saturable core reactor T3 and a rectifier input transformer T5. The reactor is in series with the primary of the autotransformer across the input terminals

Variation of the impedance of the saturable core reactor will vary the voltage impressed on the primary of the autotransformer and consequently will vary the voltage on the rectifier input transformer primary.

A decrease in reactor impedance, for instance, will increase the portion of the input voltage impressed on the autotransformer primary and will result in an increase in rectifier transformer voltage. Conversely, an increase in reactor impedance will result in a decrease in rectifier transformer voltage. The D.C. output voltage is obtained by rectifying the transformer secondary voltage in rectifier S2 and filtering in condensers C5 and C6 and choke L1. In higher voltage units S2 is replaced by one or more gas filled rectifier tubes V4.

All that is necessary to achieve voltage regulation is some automatic method of varying the reactor impedance by the right amount to restore the output voltage to its original value at such times as it may vary due to changes in load or input voltage. This action is accomplished by the electronic control circuit.

The basic voltage sensitive element is the Wheatstone Bridge R2, R3, R4 and diode V1, the filament of which is lighted by the output voltage.

The diode is operated at a temperature limited condition. With this arrangement a small increment of output voltage results in a change in cathode emission and a large change of plate resistance in the diode. The signal voltage of the bridge is applied to the grid of beam power tube V2 which controls the DC saturating current of the reactor.

A typical sequence of operations is as follows: Assume a rise in output voltage as a result of reduced load or a rise in input voltage. Increased output voltage results in increased voltage and heating of the diode filament. With increased heating, the diode cathode emission increases reducing the plate resistance of the tube. Since the diode forms an arm of the bridge, a change in plate resistance will change the balance condition of the bridge; in this instance the change results in a more negative potential applied to the grid of V2. The more negative grid signal results in a sharp drop in the plate current of V2 and consequently reduced saturation of the reactor. Reduced DC saturation of the reactor results in an increase in AC impedance which, as pointed out before, lowers the rectifier transformer voltage and hence the D.C. output voltage to a new value. The difference between the new value of output voltage and the old value of output voltage is less than the specified regulation accuracy. The gain of the circuit is sufficient to cause the necessary changes in the control circuit to adjust the output voltage for the changes in input voltage or load.

The tube V3 is a rectifier tube for the saturating circuit, and S1 a selenium rectifier for the diode bridge circuit. Adjustment of the output voltage is accomplished by the potentiometer R10 and adjustable resistor R9 in the circuit supplying the diode filament voltage. Variation of the resistance in this circuit varies the value of output voltage required to obtain a given diode filament temperature, and consequently will control the output voltage.

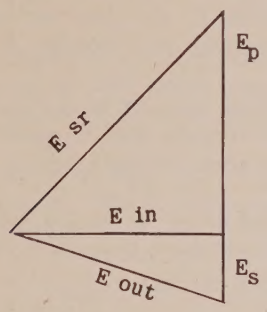
The resistor shown connected between the plate and the screen of tube V2 or across DC coil of saturable core reactor T3 is a swamping resistor to absorb inductive surges originating in the DC reactor winding. This winding has a very high inductance.

When the Nobatron is first turned on, electronic circuit elements are cold and a period of approximately 60 seconds is required for the unit to reach operating temperature. During this period, the output voltage will be low; however, as the tubes begin to conduct, the output voltage rapidly rises to its proper adjusted value. This is a normal condition and in no way indicates any malfunctioning of the regulator.

In units with Rectifier Tubes a time delay relay delays application of power to

control circuit and rectifier tube plates. During this period the output voltage is zero.

The phase relationships of the voltages in the power circuit are illustrated by the Vector diagram below:



E_s = voltage of auto trans. sec.

E_p = voltage of auto trans. primary

E_{sr} = voltage across saturable core reactor.

E in = input voltage

E rt = rectifier transformer voltage

The magnitude of the Vectors are indicative of operation of the Nobatron at full load and nominal input and nominal output.

11. MAINTENANCE AND TROUBLE SHOOTING

It was stated in the opening paragraphs of this Instruction Booklet that no tampering or adjustments should be attempted if the unit is within the warranty period without first contacting the Service Department, Sorensen & Co., Inc., or your local Sorensen representative. If the unit is outside of the warranty period it should be remembered that damage can be done to various components even when the unit is being checked. It is most necessary that the user of this equipment be familiar enough with the circuit to avoid such damage. If the simple checks outlined in this section do not point out immediately the source of trouble, the Service Department of Sorensen & Co., Inc., or the local representative of Sorensen, should be contacted immediately,

A. Maintenance

1. During normal life, the unit requires no maintenance or servicing other than the care usually afforded this type of equipment. Vacuum tubes should be replaced at the end of their specified life in accordance with the policies established for the particular application.

2. In the event of malfunctioning of the unit due to deterioration or failure of any of its component parts, a systematic checking procedure will provide the quickest and surest method of locating the difficulty. The following section gives systematic checking procedures which should be followed in locating sources of trouble.

3. The schematic shows the voltages which should exist in various parts of the circuit during normal operation. These voltages should be measured with an electronic type voltmeter.

Note: DANGEROUS VOLTAGES EXIST IN THE CONTROL CIRCUITS. OBSERVE APPROPRIATE PRECAUTIONS.

B. Trouble Shooting

1. THE FIRST STEP IN TROUBLE SHOOTING SHOULD BE TO REPLACE TUBES. IN MOST CASES THIS IS ENOUGH TO CURE THE TROUBLE.

2. Problem A - No Output Voltage

This condition indicates an open in the power circuit.

Procedure

a. Check that the On-Off control is in the "ON" position.

b. Check autotransformer, AC reactor coils, rectifier transformer,

filter choke, circuit breaker, power leads, and terminals for continuity.

c. Rectifier section may be checked separately by removing V1 and V2, and applying line voltage directly to T5 primary with about half load. This should give an output voltage near nominal.

3. Problem B - No Regulation and Low Output Voltage with Load.

This condition indicates the failure of the electronic control circuit to supply saturating current.

Procedure

a. Check the fuse in the control circuit. Replace *only* with a similar type.

b. Inspect tube filaments to see that they are lighted.

c. Check tubes in a tube tester or by replacement with tubes known to be good.

d. Check the DC power supply for for tube V2, No voltage will indicate a failure of the transformer T1, filter condenser C3, or rectifier tube V3.

e. Check the plate voltage and grid voltage of the beam power tube, V2. If the grid voltage is abnormally negative and causing cut off, check the diode filament supply voltage.

f. Check the DC reactor winding for an open.

g. Check the over-voltage circuit breaker if one is used in your unit.

h. In the case of split-chassis construction, check the interchassis plugs and sockets for secure and correct connections.

4. Problem C - No regulation and High Output Voltage.

Procedure:

a. Check to see that the diode filament is lighted.

b. Check tube V2 in a tube tester or replace with a spare that is known to be good.

c. Remove V2. If output voltage drops difficulty is in the control circuit.

d. Check V2 grid voltage to cathode or ground.

If this voltage is abnormally positive, or zero, check contacts, connections and resistance values of all components of the bridge. Check diode or replace with a spare known to be good. Check bridge rectifier S1.

e. Check the voltage adjusting potentiometer for dirty contacts.

5. Problem D - Drift with Age of the Range of Output Voltage.

This condition indicates a variation of tube characteristics with age.

Procedure:

a. Check tubes or replace with spares known to be good.

6. Problem E - Reduction of Regulation Range or Poor Regulation in General.

These conditions may be the result of deterioration or failure of various components of the control circuit.

Procedure:

a. Check tubes or replace with spares.

b. Check the DC Power supply voltages.

c. Check the control circuit in general for loose connections, shorts or damaged parts.

d. Check voltage and resistance values. Check condensers by replacement.

e. The output voltage adjustable potentiometer may cause irregular output adjustment. Turn the potentiometer shaft several times in both directions as far as it will go. This is a very low resistance adjustment and contacts can oxidize enough to cause uneven control.

f. Check output Ripple. If this is high check condensers C5 and C6 and choke L1.

In the event of serious trouble or damage to the unit, return it to the factory for repair and readjustment.

COMPENSATION PROCEDURE

Definition of compensation: Compensation in Isotronic terms means a reduction of the amount of voltage deviations caused by line or load changes.

The NOBATRON has several components that are factory adjusted to the optimum value and readjustment in the field is not recommended. However, a brief description of the procedure is given to be used in an emergency.

Adjustable resistor R8 in the cathode circuit of V2 and filament circuit of V1 is used for line compensation. With this resistor value too low increasing the input voltage will increase the output voltage. Increasing value of R8 will make the output voltage constant with varying line voltage and making value too large will cause output voltage to decrease with increasing line voltage. Under full load conditions decreasing line voltage below 100 will sometimes cause output voltage to increase when R8 is at proper value due to non linearity of V2 plate current change.

When the Nobatron is compensated for line the output voltage rises with increasing load at the point where sensing leads are connected. This is compensated for by introducing a voltage drop between the output terminals and this point. This is done by a resistor R11 in plus output leads or by using part of the voltage drop across D.C Choke L1 by means of potentiometer R12. If the output voltage rises with increasing load increase value of R11 or move slider on R12 to left.

Line compensation should be done first as the setting of R8 affects the setting of R12 or R11.

Another adjustment involves the resistor designated R9. Adjustment of the resistor may be necessary when a new diode is installed and the voltage adjustment potentiometer does not permit setting the output voltage between specified values.

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